

Application No. 10/591,476
Amendment dated Feb. 16, 2010
Reply to Office Action of October 16, 2009

Atty. Docket No. 033082 M 343

REMARKS

The Office Action mailed on October 16, 2009, has been received and its contents carefully noted. Claims 1-24 were pending. Claims 15 and 16 are withdrawn from consideration as being directed to a non-elected invention. Claims 1-14 and 17-24 are rejected. Acknowledgment has been made of Applicants' Claim for Priority. The Information Disclosure Statements filed March 11, 2009, April 25, 2008, March 19, 2007, February 22, 2007 and September 1, 2006 have been considered.

By this response, claims 1 and 19 have been canceled. Claims 5, 8 and 9 have been amended to correct very minor errors. No change in scope has been made to the claims. No statutory new matter has been added. Support for all amendments can be found in the original specification.

Applicants submit a Petition for one-month Extension of Time, with the requisite fee, to effect these changes.

Claim Rejections under 35 U.S.C. § 102(b)

Claim 1 stands rejected as being anticipated by Mouche (Metal-organic chemical vapor deposition of copper using hydrated copper formate as a new precursor). The rejection as to claim 1 is moot upon cancellation. Withdrawal of the rejection is requested by Applicants.

Claim Rejections under 35 U.S.C. § 103(a)

Claims 2 and 5-6 stand rejected as being unpatentable over Mouche in view of Norman (US 2002/0013487). Claims 3-4 and 17-18 stand rejected as being unpatentable over Mouche in view of Norman in view of Sneh (US 2001/0002280). Claim 7 stands rejected as being unpatentable over Mouche in view of Norman in view of Krupoder (Polyfluorocarboxylates. I. Copper (II) trifluoroacetate and its analogues). Claim 19 stands rejected as being unpatentable over Mouche in view of Krupoder. Claim 20 stands rejected as being unpatentable over Mouche in view of Norman in view of Sneh in view of Krupoder.

The rejection as to claim 19 is moot upon claim cancellation. The rejections as to claims 2-7, 17 and 18 are traversed.

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Applicants urge that the combination of Mouche and Norman with respect to claim 2 and the combination of Mouche, Norman and Sneh with respect to claim 3 fail to teach or suggest Applicants' step of *"supplying a source material including a Cu-carboxylic acid complex or a derivative thereof onto a substrate"* in an ALD process.

Applicants' method alternately supplies a precursor of a Cu-carboxylic acid or a derivative thereof and a reductive gas by atomic layer deposition (ALD). Applicants' advantages of using a source material of Cu-carboxylic acid or a derivative thereof are: a higher vapor pressure which allows a source material with a higher concentration to be used; thus, a high "wettability" to a base substrate preferably forms a continuous, smooth Cu film with high quality. This is possible even with a small film thickness. In addition, a high film deposition rate is attained because of the source material's high polarity and absorption efficiency to a base substrate.

On the other hand, the primary reference of Mouche describes a conventional CVD process wherein the source gas and carrier/reduction gas are supplied concurrently (e.g., at the same time). The alleged secondary reference of Norman suggests a Cu-complex source gas and a reductive gas being supplied alternatively in an ALD process, or a sequential CVD process. However, as understood by Applicants, Norman does not suggest the use of a Cu-carboxylic acid complex or a derivative thereof as a precursor (e.g., source material) in an ALD process.

In Sneh, an ALD process using a metal-containing precursor and a reducing agent is disclosed. Similar to Norman, Sneh also fails to disclose the use of a Cu-carboxylic acid complex or a derivative thereof as a precursor in an ALD process. Thus, Norman and Sneh lack the necessary guidance to suggest the modification of Mouche's CVD process that concurrently supplies carrier/reductive gas. Accordingly, Applicants submit that one of ordinary skill in the art would not have relied upon the combination of either Mouche and Norman or Mouche, Norman and Sneh to teach the step of *"supplying a source material including a Cu-carboxylic acid complex or a derivative thereof onto a substrate"* in an ALD process. As such, claims 2 and 3 patentably distinguish thereover.

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Applicants also submit that the above-recited advantages further distinguish claims 2 and 3 over the asserted combinations. That is, the advantages attained by Applicants' claimed method using a precursor of Cu-carboxylic acid or a derivative thereof were not known in the art.

As to claims 7 and 20, Applicants submit that Krupoder fails to remedy the deficiencies of Mouche, Norman and Sneh as to claims 2 and 3. Therefore, claims 7 and 20 also patentably distinguish thereover.

In view of the foregoing, reconsideration and withdrawal of the rejections as to claims 2 and 3, and claims 4-7, 17-18 and 20, dependent thereon, are courteously requested by Applicants.

Claims 8 and 11-14 stand rejected as being unpatentable over Norman in view of Chen (US 2003/0129308). Claims 9-10 and 21-24 stand rejection as being unpatentable over Norman in view of Sneh in view of Chen. Both rejections are traversed.

Regarding claims 8 and 9, the Office Admits Norman's deficiency concerning alternating periods for deposition. Accordingly, the Office Action relies upon Chen.

Applicants urge that the combination of Norman and Chen with respect to claim 8 and the combination of Norman, Sneh and Chen with respect to claim 9 fail to teach or suggest Applicants' method having a reductive gas supply time of a second deposition period that is shorter than a reductive gas supply time of a first deposition period.

Applicants' method is defined by two deposition periods, each alternately supplying a precursor and a reducing gas, in an ALD process. See FIG. 4. The reductive gas supply time T2 in the second deposition period is shorter than the reductive gas supply time T2 in the first deposition period. See para. [0017]. Specifically, T1 is set relatively long so as to prevent impurities such as carbon originating from the source material which appear on an interface between the base substrate and the Cu film; and also to prevent the negative effects of oxidization of the base. Thus, a continuous Cu film with excellent film quality is formed.

Also, since the reductive gas supplied in T2 is set to be relatively short, the time required for film deposition in later stages is shortened. Therefore, the total process time for film

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deposition is shortened, resulting in an improvement in process throughput and an improvement in quality of the Cu film formed by the ALD process.

By contrast, Chen fails to teach or suggest that the reductive gas supplying period T2 in a later stage is shorter than the reductive gas supplying period T1 in an early stage. While Chen discloses different values for deposition cycles T1-T4, there is no indication or suggestion in Chen that a deposition cycle T2 in a later stage is shorter than the deposition cycle T1 in an early stage. Because of the lack of guidance in Chen to select a deposition cycle T2 that is shorter than a deposition cycle T1, Chen fails to teach Applicants' features of claims 8 and 9. It is also urged that Sneh fails to teach this features. In view of the foregoing, Applicants submit that claims 8 and 9 are patentably distinguishable over the asserted combinations. As such, reconsideration and withdrawal of the rejections as to claims 8 and 9, and claims 10-14 and 21-24, dependent thereon, are earnestly solicited by Applicants.

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CONCLUSION

All of the stated grounds of rejection have been properly traversed, accommodated, or rendered moot. Therefore it is respectfully requested that the Examiner reconsider the presently outstanding rejections and that they be withdrawn. It is believed that a full and complete response has been made to the outstanding Office Action and, as such, the present application is in condition for allowance. If the Examiner believes, for any reason, that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at the number provided.

It is not believed that extensions of time are required, beyond those that may otherwise be provided for in accompanying documents. However, in the event that additional extensions of time are necessary to prevent abandonment of this application, then such extensions of time are hereby petitioned under 37 C.F.R. 1.136(a), and any fees required therefore are hereby authorized to be charged to **Deposit Account No. 02-4300, Attorney Docket No. 033082 M 343.**

Respectfully submitted,

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